



# **Swift Burst Alert Telescope (BAT) Mask Qualification Panel Lead Bonding Procedure**

**410.4-PROC-0054**

**Revision -**

**Goddard Space Flight Center**

Greenbelt, Maryland

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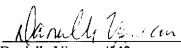


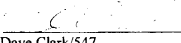
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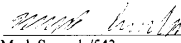
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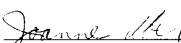
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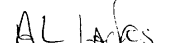
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## CHANGE RECORD PAGE (1 of 2)

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## 1 General

### 1.1 Introduction

The BAT instrument requires a coded aperture mask that is 4'x 8'x 1.54" in size. Approximately 52,000 lead tiles (5x5x1 mm) will be bonded to the mask in a predetermined random pattern covering about 50% of the panel surface. A 4'x4' qualification panel will be used to verify the bonding process and the strength of the panel. This document outlines that process to bond the lead tiles onto the qualification panel.

### 1.2 Applicable Documents

GSFC-Swift-410-Spec-002	Swift Mission Assurance Requirements Document
410-4-PG-8730.3.1	Swift Quality Management Plan
410.4-MGMT-0005	BAT Mechanical Requirements Document
NHB8060.1	Flammability Odor and Offgassing Requirements
NSS/GO-1740.9B	NASA Safety Standard for Lifting Devices and Equipment, November 1991
NASA/GSFC	Engineering Services Division Safety Manual, September 1990
GMI 1710.6	Design, Inspection, and Certification of Lifting Devices and Equipment, May 1988
X-673-64-1F	Engineering Drawing Standards Manual
S-313-100	GSFC Fastener Integrity Requirements
MIL-STD-889B	Dissimilar Metals
410.4-PROC-0051	Lead Tile Precuring Procedure
410.4-PROC-0056	Lead Tile Ceaning Procedure
410.4-PROC-0057	CF2-136 Primer Application Procedure
410.4-PROC-0058	CV10-2568 Adhesive Mixing Procedure

### **1.3 Applicable Drawings**

GE2045207 Mask Qualification Panel

GE2049868 Mask Qualification Panel Skim Template

GE2049855 Machined Mask Qualification Panel

GD2049856 Mask Fiducial Alignment Insert

GE2045204 Coded Mask Panel Tile

GE2045212 Mask Z-Shield Insert

GD2045205-001 Mask Clearance Hole Insert, Plug

GD2045205-003 Mask Clearance Hole Insert, Sleeve

GE2049863 Mask Panel/Tile Placement Center Template

GE 2049865 Rev B Mask Panel/Tile Placement Fixture Plate

GE2049861 Rev B Mask Panel/Tile Placement Template Assembly

### **1.4 Responsibilities**

The BAT Mask Lead Engineer is responsible for providing authorization for the activity, technical advice, assistance during handling operations, coordination, and notification to all applicable personnel. Only trained and qualified personnel, Mike Schoolman, Danielle Vigneau, and Dave Clark, are permitted to perform the following tasks. Additional personnel will only be used if specifically authorized by the cognizant engineer.

The GSFC Code 300 Quality Assurance (QA) representative shall be responsible for monitoring the operation and verifying all steps are performed by signing off each event number and/or page as indicated.

### **1.5 Safety**

Emergency Actions: When an unsafe condition exists, the Mask Lead Technician will take immediate action to prevent injury to personnel or hardware.



## **1.6 Procedure Deviations**

Deviations from this procedure shall be redlined in the official copy and will be initialed by the BAT Mechanical PDL and or designee and QA representative.

## **1.7 Quality Assurance**

QA will monitor all operations as specified in this procedure. They shall stamp or initial to verify that all operations listed are acceptable as indicated.

## **1.8 Implementation**

Only those actively engaged in the operations and the designated safety and QA representatives will be allowed in the controlled area.

# **2 Overview**

## **2.1 Panel Description**

The qualification panel was fabricated per drawing 2045207 at Composite Optics International (COI) in San Diego, CA. The 4'x 4' panel consists of a Korex core 1.5" thick (3/16" cell size, 2 pcf), with two graphite-cyanate ester facesheets. The facesheets are each .020" thick using a quasi-isotropic layup, [0,45,90,-45]S of preimpregnated plies of M60J fibers embedded in a 954-3 resin matrix. Approximately 30,000 lead tiles will be bonded to one surface of the panel with NuSil's CV10-2568 silicone adhesive. It is essential to the science team to avoid even trace amounts of adhesive in the untiled areas.

## **2.2 Qualification Panel Objectives**

There are several goals that the qualification panel:

1. Verify that the lead tile bonding procedure works on a larger scale by demonstrating that the
  - a. tile placement is within positional tolerance requirements
  - b. tiles have sufficient adhesion to the panel
  - c. adhesive adequately covers the tiles
  - d. adhesive does not extend into untiled areas
2. Demonstrate a tile replacement procedure
3. Demonstrate that the panel itself has adequate strength through acoustic and thermal vacuum tests

### 2.3 Bonding Process Summary

The facesheets of the panel will be machined per drawing GE2049855 and the honeycomb core will be removed in a secondary operation. The core will be removed from fiducial holes flush with the facesheet hole diameter. The honeycomb core will be removed an extra two cells around the perimeter of the graded z inserts. The core will be removed to achieve a 0.5" diameter hole centered in each of the 6 mounting holes.

The graded z locations will be potted with EY3010 (formerly SLE3010) and sanded flush with the facesheets. The bagged side has been part marked and the tiles will be bonded to the opposite skin. The tile bonding surface will be surface prepped using red scotchbrite (7447) and cleaned with acetone followed by alcohol using extracted wipes.

The flanges of the fiducials have been bonded to the panel by lowering the fiducials thru the bagged side of the panel onto stepped pins in the alignment holes of the tile tool. The fiducials were potted by taping off the tile side of the hole in the facesheet and injecting EY3010. These fiducials will be used for verifying positional accuracy and locating the skim coat template.

The skim template should be visually inspected by pinning it to the tile tool. The inspection should verify that the skim coat template features lie centered within the tile pockets. The corner fitting locations of the skim template should be marked, cut away, and taped. The central fitting locations should be marked, taped off, and holes should be placed in the tape to allow pinning into the fiducials.

The lead tiles will be cleaned per [410.4-PROC-0056](#) and primed per [410.4-PROC-0057](#). A 0.23" thick layer of CV10-2568 will be precured to the tiles per [410.4-PROC-0051](#) using the [410.4-PROC-0058](#) adhesive mixing procedure. Finished tiles will be bagged and identified in lots of ~ 901 tiles. These precured tiles will be placed, adhesive side up, in the tile tool. The tool should be populated from the center outward using the four quadrants indicated as guidelines for batch perimeters. All pertinent batch information and the relative placement areas should be recorded on the tool for future reference.

The Z brackets for the lowering fixture should be installed in the panel. The vacuum bag should be cut to size and placed over the three mounts with tacky tape sealing the interfaces. All sealing efforts at these bracket locations should be completed prior to the dry fit checkout.

The mounts will be hand lowered onto the ball bearings at each interface of the three synchronized actuators. The actuators should be positioned such that the ball bearings contact the mating surface properly. Drill blanks will be installed through the Qual panel fiducials and must drop into the tile tool alignment holes to verify positional accuracy. The pins and panel should be removed and replaced to verify repeatability.

Once again, the pins and panel will be removed. The panel should be placed Z bracket side down and the skim template should be pinned and taped in position for priming per [410.4-PROC-0057](#). Immediately following the priming, CV10-2568 adhesive will be mixed per [410.4-PROC-0058](#). Adhesive will be applied to the skim template on the panel with two large squeegees pulling from the center outward until a uniform coat is achieved. The skim coat template should then be removed.

The panel will be flipped, adhesive side down, and the mounts will be placed on the actuator ball bearings. This system will lower the panel to within 6 mm and the pins should be engaged and should drop into the tool. The pins should be removed and the panel to verify positional accuracy by placing the pins through the fiducial holes and into the tile tool alignment holes.

Once the panel contacts the tiles, the lowering device should be lowered for clearance during bagging operations and vacuum. The regulator should be set to 4 inches of Mercury (~2 psi). The banking bars should be placed around the panel perimeter and breather should be located as required. Tacky tape should be placed around the edge and the vacuum bag should be sealed. Two gages will be used to monitor the pressure, one at each end of the panel.

The panel should be allowed to cure a minimum 18 hours at room temperature. The three jack screws will be turned simultaneously to raise the panel from the tile tool evenly. The panel should be removed and tiles should be visually inspected at this point. Any unbonded tiles should be inspected further. Subsequently, any acceptable unbonded or misaligned tiles will be rebonded using the repair procedure, as needed.

### 3 Requirements

#### 3.1 Required Equipment

4'x 4' Mask Qualification Substrate  
30,000 4 mm Precured Lead Tiles  
Synchronized Actuator Assembly  
4'x 4' Tile Tool  
Three 3/16" Allen Wrenches  
Red Scotch Brite  
ACS Grade Acetone  
Extracted Wipes  
Green Non-Silicone Flashbreaker Tape  
Three Quick Disconnect Vacuum Ports  
2 Large Stainless Steel Squeegees  
CV10 – 2568 Silicone Adhesive

Three Z Bracket Assemblies  
500 3 mm Precured Lead Tiles  
Actuator Controller & CPU  
4'x 4' Skim Template  
[0.75" Wrench](#)  
180 Grit Sandpaper  
ACS Grade Isopropanol  
Calibrated Scale  
Standard Lab Bagging Materials  
Two Vacuum Gages  
Banking Bar Assembly  
CF2-136 Primer

M5 Cab-o-sil  
Ventilation System

Bell Jar with Turbo Vacuum  
Nitrogen Tank

Alignment Pins: 2x ¼", 2x 6.3mm (0.2498"), 2x 6.25mm (0.2496)

### 3.2 Required Personnel

#### Title

#### Name

BAT Mask Lead Engineer  
Mask Lead Technician  
Manufacturing Engineer  
Quality Assurance

Danielle Vigneau  
Mike Schoolman  
Dave Clark  
Al Lacks

## 4 Procedures

### 4.1 Tool Population

Event #	Responsible Code	Event Description	Signature and Date		NCR #	Product Disposition Completion Date
			17. Performed by	18. Inspected by		
4.1.1		For simplified record keeping, populate tile tool with the 4 mm precured lead tiles along the 4 quadrant boundaries indicated on the tool.				
4.1.2		Start populating the tool from the center and progress outward following quadrant boundaries guidelines. <b>Note: Tiles batches should be kept together in square or rectangular regions of the tool.</b>				
4.1.3		Any precured tiles with precured squeeze out or any type of irregular adhesive surface should be trashed.				
4.1.4		Place tiles, adhesive side up, in the pockets. Tiles should fit easily, but not loosely, into pockets.				
4.1.5		Tile fit is critical. If a tile fits tightly, remove the tile and check the pocket for debris <b>DO NOT FORCE TILES.</b>				
4.1.6		If the fit is still tight, install the GO gage into the pocket to verify proper pocket size.				
4.1.7		Any precured tiles not seating level in a pocket after checking for debris and using the GO gage must be trashed.				
4.1.8		Record batch identification and mark the perimeter of the batch placement area on the tool with a Sharpie for reference.				

Event #	Responsible Code	Event Description	Signature and Date		NCR #	Product Disposition Completion Date
			17. Performed by	18. Inspected by		
4.1.9		At the four locations on the tool identified with a red Sharpie, remove the 4 mm precured tiles inside the red lines and replace these with 3 mm precured tiles.				
4.1.10		Inspect the tile surface for unseated or misplaced tiles, using the laser, mount, and track.				
4.1.11	QA303	<b>Visually inspect the tiles to verify all tiles are properly seated in their pockets. Viewing the tile plane from the edge is most effective.</b>				

## 4.2 Panel Preparation

Event #	Responsible Code	Event Description	Signature and Date		NCR #	Product Disposition Completion Date
			17. Performed by	18. Inspected by		
4.2.1		Remove previously bonded CV10-2568 adhesive by lightly abrading the bonding surface with 180 grit sandpaper.				
4.2.2		Clean the surface with ACS Grade Acetone followed by Isopropanol, using extracted cotton wipes.				
4.2.3		Install the Z brackets in the panel such that datums 1 and 2 (point & line, respectively) are on the panel side with 2 actuators. Datum 3, the plane, is on the central mount location.				
4.2.4		Do not attempt to preload the bolts, the threads have been sized for the proper fit.				

## 4.3 Lowering System Checkout & Panel Alignment

Event #	Responsible Code	Event Description	Signature and Date		NCR #	Product Disposition Completion Date
			17. Performed by	18. Inspected by		
4.3.1		<b>Caution: Prior to any actuator operations, always remove pins unless explicitly stated.</b>				
4.3.2		Home actuators and verify synchronization of actuators during lowering system operations.				

Event #	Responsible Code	Event Description	Signature and Date		NCR #	Product Disposition Completion Date
			17. Performed by	18. Inspected by		
4.3.3		Position precision safety blocks at three fitting location pockets, machined surface up, directly on tool surface.				
4.3.4		Lower the panel with the actuators until they rest on the safety blocks.				
<b>4.3.5</b>	<b>QA 303</b>	Adjust panel position until 6.30 mm diameter pins fall through both fiducial inserts and into the tool alignment holes. Verify accurate positioning by freely spinning pins.				
4.3.6		Raise actuators until mount surfaces almost contact the ball bearings.				
4.3.7		Adjust actuator locations until ball bearings are centered within the contact surfaces of the position datums 1, 2 and 3, (point, line, and plane, respectively) in that order.				
4.3.8		Secure actuators to granite table and/or place weights on the support structure to stabilize actuator locations.				
4.3.9		Using a height indicator, measure and record the bottom surface of the panel in three locations near the safety blocks.				
4.3.10		Simultaneously adjust ball bearing jack screws at each interface until barely contacting mating surfaces of the position datums 1, 2 and 3.				
4.3.11		Lock jack screws and remove pins.				
4.3.12		Raise actuators 5 mm. Measure and record the bottom surface of the panel in the three locations near the safety blocks.				
4.3.13		Compare measurements to verify actuator support maintains safety block support plane within 0.003".				

#### 4.4 Panel to Tile Tool Alignment

	Responsible Code	Event Description	Signature and Date		NCR #	Product Disposition Completion Date
			17. Performed by	18. Inspected by		
4.4.1		<b>Caution: Prior to any actuator operations, always remove pins unless explicitly stated.</b>				

	Responsible Code	Event Description	Signature and Date		NCR #	Product Disposition Completion Date
			17. Performed by	18. Inspected by		
4.4.2		Raise panel as required and remove safety blocks.				
4.4.3		Using actuator system, lower panel until approximately 10 mm from the tile surface.				
4.4.4		Insert two 6.3 mm diameter pins through fiducials and verify tool alignment hole engagement.				
4.4.5		Verify accurate positioning by freely spinning pins. Remove pins.				
4.4.6		Lower panel using actuators to approximately 2 mm above tile surface. Insert 6.3mm diameter pins and verify tool alignment hole engagement.				
4.4.7		Verify accurate positioning by freely spinning pins. Remove pins.				
4.4.8		Lower panel using actuators until panel contacts the tile surface. Insert 6.3mm diameter pins and verify tool alignment hole engagement.				
4.4.9		Verify accurate positioning by freely spinning pins. Remove pins and raise panel 10 mm.				

## 4.5 Vacuum Pre-Bagging Procedure

Event #	Responsible Code	Event Description	Signature and Date		NCR #	Product Disposition Completion Date
			17. Performed by	18. Inspected by		
4.5.1		<b>Caution: Minimize Z Bracket contact to avoid misalignment.</b>				
4.5.2		Remove panel from actuators and place on table with tile bonding surface down on clean Teflon surface.				
4.5.3		Apply tack tape to the Z bracket support areas to seal the bolt holes and perimeter of the Z bracket support.				
4.5.4		Place vacuum bag over panel and cut three slices directly over mount locations. Gently pull bag over mounts taking care not to disturb mount positioning.				

Event #	Responsible Code	Event Description	Signature and Date		NCR #	Product Disposition Completion Date
			17. Performed by	18. Inspected by		
4.5.5		Seal the holes in the bag to the tacky tape on the Z brackets without disturbing the bracket positioning.				

#### 4.6 Alignment Repeatability Verification

Event #	Responsible Code	Event Description	Signature and Date		NCR #	Product Disposition Completion Date
			17. Performed by	18. Inspected by		
4.6.1		Place pre-bagged panel on actuators system.				
4.6.2		Lower panel using actuators to approximately 2 mm above tile surface. Insert 6.3mm diameter pins and verify tool alignment hole engagement.				
4.6.3		Verify accurate positioning by freely spinning pins. <b>Leave pins in place.</b>				
4.6.4		Lower panel using actuators until panel contacts the tile surface. Insert 6.3mm diameter pins and verify tool alignment hole engagement. Verify pin feel is unchanged.				
4.6.5		Verify accurate positioning by freely spinning pins. Lower actuators 30 mm to provide clearance.				

#### 4.7 Vacuum Seal and Contact Verification

Event #	Responsible Code	Event Description	Signature and Date		NCR #	Product Disposition Completion Date
			17. Performed by	18. Inspected by		
4.7.1		Perform Vacuum Bagging Procedure per Section <b>4.12.</b>				
4.7.2		Verify accurate positioning by freely spinning pins. Remove pins and raise actuators ~30 mm to engage Z brackets.				
4.7.3		Raise panel 10 mm and remove panel from actuators. Being careful to avoid any contact with the Z brackets, place panel, tile bonding side up, on the table.				
4.7.4		Replace any dislodged or raised tiles in pockets. Verify uniform tile surface and adjust raised tiles as required.				



Event #	Responsible Code	Event Description	Signature and Date		NCR #	Product Disposition Completion Date
			17. Performed by	18. Inspected by		
4.7.5		Verify contact by noting smudge intensity and clarity on the panel surface.				

#### 4.8 Priming and Skim Template Preparation

Event #	Responsible Code	Event Description	Signature and Date		NCR #	Product Disposition Completion Date
			17. Performed by	18. Inspected by		
4.8.1		Locate priming template on panel using pins in the fiducial locations.				
4.8.2		Overlay the skim template and verify the skim template holes fall within the priming template holes.				
4.8.3		Indicate the exposed side of the templates should be located face up using a Sharpie.				
4.8.4		Indicate fitting areas on both priming and skim templates with a Sharpie.				
4.8.5		Remove the templates and cut these areas out leaving a ½ " border along the perimeter to secure the templates to the panel with tape.				

#### 4.9 Panel Priming

Event #	Responsible Code	Event Description	Signature and Date		NCR #	Product Disposition Completion Date
			17. Performed by	18. Inspected by		
4.9.1		Lightly abrade the bonding surface with red scotch brite to remove smudges.				
4.9.2		Clean the surface with ACS Grade Acetone followed by Isopropanol, using extracted cotton wipes.				
4.9.3		Blow the surface dry with Nitrogen. <b>Bond within 24 hours or cover surface.</b>				
4.9.4		Locate the 0.007" thick G10 priming template (4 mm squares with 0.0625" radius) to the panel using 2 alignment pins in the fiducials of the panel.				
4.9.5		Tape available edges to provide the positional stability.				

Event #	Responsible Code	Event Description	Signature and Date		NCR #	Product Disposition Completion Date
			17. Performed by	18. Inspected by		
4.9.6		Apply NuSil's CF2-136 red silicone primer to panel per <b>410.4-PROC-0057</b> . <b>Record Prime Time:</b>				
4.9.7		Air dry at RT and a minimum of 30% RH. <b>Note: Dry a minimum of 30 minutes.</b> <b>Start Time:</b> <b>End Time:</b>				
4.9.8		Remove the pins and the priming template.				

#### 4.10 Adhesive Skim Application

Event #	Responsible Code	Event Description	Signature and Date		NCR #	Product Disposition Completion Date
			17. Performed by	18. Inspected by		
4.10.1		Locate the skim template (1.3 mm diameter holes) to the panel using 2 alignment pins in the fiducials of the panel.				
4.10.2		Verify these holes line up within the primed locations before proceeding.				
4.10.3		Tape available fitting location cutouts and available edges to provide sufficient the positional stability but avoid creating wrinkles in the template.				
4.10.4		Mix NuSil's 2 part CV10-2568 silicone adhesive and Cabot's M5 Cabosil per <b>410.4-PROC-0058</b> . <b>Record Mix Date:</b> <b>Mix Time:</b> <b>Lot # 21039 Recommended Shelf Life is 3 hours.</b> <b>Apply Vacuum within 2 hours of Mix Time.</b>				
4.10.5		Clean two large stainless steel squeegees using ACS Grade Acetone followed by Isopropanol and extracted wipes.				
4.10.6		Apply adhesive to the center of the panel and work the adhesive toward the edges using cleaned squeegees.				
4.10.7		After completing the initial coat, add & work adhesive to avoid biasing. <b>Record Start Time:</b> <b>End Time:</b> <b>Apply Vacuum within 2 hrs of recorded Mix Time.</b>				
4.10.8		Remove the alignment pins and any tape used to secure the skim template.				

Event #	Responsible Code	Event Description	Signature and Date		NCR #	Product Disposition Completion Date
			17. Performed by	18. Inspected by		
4.10.9		Carefully remove skim template to avoid peeling up or deforming adhesive cylinders.				
4.10.10		Clean any excess or smeared adhesive using cotton swabs. As required, clean areas with cotton swabs and Isopropanol to remove any residue.				
4.10.11	QA303	<b>Check that adhesive dots on the panel are uniform. Verify adhesive is still tacky by checking witness sample.</b>				

#### 4.11 Tile Bonding Operation

Event #	Responsible Code	Event Description	Signature and Date		NCR #	Product Disposition Completion Date
			17. Performed by	18. Inspected by		
4.11.1		Locate the panel, adhesive side down, on the three ball bearings of the actuator system.				
4.11.2		Lower panel using actuators to approximately 2 mm above tile surface. Insert 6.3mm diameter pins and verify tool alignment hole engagement.				
4.11.3		Verify accurate positioning by freely spinning pins. <b>Leave pins in place.</b>				
4.11.4		Lower panel using actuators until panel contacts the tile surface. Insert 6.3mm diameter pins and verify tool alignment hole engagement. Verify pin feel is unchanged.				
4.11.5		Verify accurate positioning by freely spinning pins. Lower actuators 30 mm to provide clearance.				
4.11.6	QA303	<b>Verify that the alignment pin fits through both fiducials and into the tile tool alignment hole.</b>				

#### 4.12 Vacuum Bagging Procedure

Event #	Responsible Code	Event Description	Signature and Date		NCR #	Product Disposition Completion Date
			17. Performed by	18. Inspected by		

Event #	Responsible Code	Event Description	Signature and Date		NCR #	Product Disposition Completion Date
			17. Performed by	18. Inspected by		
4.12.1		<b>CAUTION: Do Not Touch the Z Brackets after alignment and pre-bagging operations.</b>				
4.12.2		Install banking bar system, vacuum ports, and apply tacky tape around the perimeter. Apply breather as required.				
4.12.3		Seal edge of vacuum bag to tacky tape. Install tacky tape ears in the four corners.				
4.12.4		Verify regulator is set to 4 inches of mercury. Remove the regulator and install two vacuum gages to the bag.				
4.12.5		Apply the vacuum while monitoring the gages for needle movement and pin locations for break though. Apply tacky tape to pin and seal bag as required.				
4.12.6		Check bag seals, especially the bracket locations, until the gages read 3 inches of mercury. Remove the vacuum hose and install the regulator.				
4.12.7		Allow the vacuum to pull down at 4 inches of mercury <b>Record Start Time:</b> <b>Verify Start Time is within 2 hours of Mix Time.</b>				

### 4.13 Panel Removal Operation

Event #	Responsible Code	Event Description	Signature and Date		NCR #	Product Disposition Completion Date
			17. Performed by	18. Inspected by		
4.13.1		Allow a minimum of 18 hours to cure silicone. <b>Record End Time:</b>				
4.13.2		Engage an allen wrench in each of the three jack screws.				
4.13.3		To raise the panel evenly, turn each wrench in 1/4 turn increments simultaneously. Repeat this process until the panel is visibly disengaged from the tool.				
4.13.4		Carefully remove the panel and place, tile side up, on the table.				
4.13.5	QA 303	<b>Visually inspect panel for any unbonded or misaligned tiles.</b>				

Event #	Responsible Code	Event Description	Signature and Date		NCR #	Product Disposition Completion Date
			17. Performed by	18. Inspected by		
4.13.6		Allow an additional 6 days at room temperature to fully cure adhesive. <b>Record Start Date:</b> <b>Completion Date:</b>				
4.13.7		Contact BAT Science Team for disposition on unbonded tiles.				
4.13.8		If needed, remove misaligned tiles and rebond with unbonded tiles using the repair procedure <b>BAT-MECH-004</b> .				
4.13.9		If repair bond is unnecessary, remove Z bracket mounts.				